PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/765,815
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Applicant:	Peter Pospishal et al.
Group Art Unit:	1745
Examiner:	Tony Sheng Hsiang Chuo
Title:	VIRTUAL COMPRESSOR OPERATIONAL PARAMETER MEASUREMENT AND SURGE DETECTION IN A FUEL CELL SYSTEM
Attorney Docket:	GP-304283

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APPELLANT'S APPEAL BRIEF

This is Appellant's Appeal Brief filed in accordance with 37 CFR § 41.37 appealing the Examiner's Final Office Action mailed September 26, 2007. Appellant's Notice of Appeal was filed on December 19, 2007. The Appeal Brief fee is enclosed.

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Table of Authorities

I. Real Party in Interest

The real party in interest for this appeal is the General Motors Corporation of Detroit, Michigan, the assignee of this application.

II. Related Appeals and Interferences

There are no related appeals or interferences.

III. Status of the Claims

Claims 1-20 are pending in this application. Claims 7-12, 14, 15 and 20 have been withdrawn from consideration as being directed to a non-elected species. Claims 1-6, 13 and 16-19 stand rejected. Claims 1-6, 13 and 16-19 are on appeal. No claim has been cancelled. No claim has been allowed. No claim has been objected to.

IV. Status of Amendments

All amendments have been entered.

V. Summary of Claimed Subject Matter

Each of the independent claims 1, 13 and 18 claims storing a compressor map defining the operation of a compressor used in a fuel cell system. Figure 1 is a graph with mass flow on the horizontal axis and discharge pressure on the vertical axis showing a typical example of a compressor map 50 for a turbo-machine type compressor. The compressor map 50 includes a surge line 54 where if the operation of the compressor is on a left side of the line 54, it is in a surge condition that could cause damage to the compressor, see paragraph [0007], page 2, line 19 - page 3, line 3.

Independent claims 1, 13 and 18 claim a fuel cell system, such as fuel cell system 10 shown in figure 2, and discussed in the specification beginning at paragraph

[0017], page 5, line 1. The fuel cell system 10 includes a fuel cell module 14 (independent claims 1, 13 and 18) and a compressor 16 (independent claims 1, 13 and 18) that provides an airflow to the cathode side of the fuel cell module 14, paragraph [0018], page 5, lines 6 and 7. The fuel cell system 10 also includes a mass flow meter 22 (independent claim 1) that receives the airflow sent to the compressor 16 and provides an airflow signal indicative of same, paragraph [0019], page 5, lines 24-28. The fuel cell system 10 also includes a motor 18 (independent claims 1, 13 and 18) for driving the compressor 16, paragraph [0019], page 5, lines 21-23. The fuel cell system 10 also includes a controller 28 (independent claims 1, 13 and 18) that provides a signal to the motor 18 to control the speed of the compressor 16, paragraph [0019], page 5, lines 27-29.

The controller 28 digitally stores the compressor map 50 of the compressor 16, paragraph [0020], page 6, lines 3-6. The controller 28 determines the discharge pressure and temperature of the compressor 16 from the speed of the compressor 16 and the airflow signal from the mass flow meter 28 (independent claim 1), paragraph [0020], page 6, lines 6-8. The controller 28 also determines the location on the compressor map 50 at which the compressor 16 is operating and prevents the compressor 16 from entering a surge condition as the operation of the compressor 16 moves relative to the surge line 54, (independent claims 1, 13 and 18), paragraph [0020], page 6, lines 9-13.

VI. Grounds of Rejection to be Reviewed on Appeal

Whether claims 18 and 19 should be rejected under 35 USC 102(b) as being anticipated by Japanese Patent Publication No. 60-160574 to Mitani et al. (hereinafter Mitani). A complete translation of Mitani is being provided herewith;

Whether claims 1, 2, 4-6, 13, 16 and 17 should be rejected under 35 US 103(a) as being unpatentable over U.S. Patent Publication No. 2002/0039672 to Aramaki (hereinafter Aramaki) in view of Mitani; and

Whether claim 13 should be rejected under 35 USC 103(a) as being unpatentable over Aramaki in view of Mitani and U.S. Patent Application Publication No. 2002/0150805 to Stenersen et al. (hereinafter Stenersen).

VII. Argument

A. Claims 18 and 19 are not anticipated by Mitani

1. Independent claim 18

Independent claim 18 claims a method for preventing a surge condition of a compressor in a fuel cell system that includes storing a compressor map of the compressor and using the compressor map and the speed of the compressor to determine the location on the compressor map that the compressor is operating and preventing the compressor from entering the surge condition.

2. Mitani

Mitani discloses a turbo-compressor system for fuel cell power generation. The system includes a turbine 14 that drives a compressor 12, where the compressor 12 provides a flow of air on air feed line 15 to an air chamber 8 in a fuel cell 1. Figure 1 in Mitani shows a compressor map similar to the compressor map in figure 1 of Appellant's Specification. The Mitani compressor map includes a surge line I that separates the map into a surge portion A on the left side of the line I where the compressor 12 is in a surge condition, and a non-surge portion B on the right side of the line I where the compressor 12 is not in a surge condition. A by-pass line 17 is provided from the feed line 15 to a line 16 between the turbine 14 and a modifier 2. A flow regulating valve 18

is provided in the by-pass line 17, and controls the flow from the feed line 15 to the line 16. When the operation of the compressor 12 enters the area A where it is in a surge condition, the flow regulating valve 18 is opened so that some of the feed air on the feed line 15 is directed to the line 16 to increase the speed of the turbine 14, and thus, the speed of the compressor 12. By increasing the speed of the compressor 12, the operating condition of the compressor 12 is returned to area B.

3. Discussion

Appellant respectfully submits that their method for preventing compressor surge of independent claim 18 is different than what is fairly taught or suggested by Mitani. Appellant's claimed method stores the compressor map, and uses the speed of the compressor to determine where on the compressor map the compressor is operating so that the controller can prevent the compressor from entering the surge condition <u>prior</u> to it happening so that the compressor never enters the surge condition. In other words, as the speed of the compressor moves towards and becomes close to the surge line in the stored compressor map, the system takes suitable action, such as by increasing the speed of the compressor, to prevent the surge condition form occurring.

The relationship of discharge pressure and mass airflow for a compressor shown in figure 1 in Appellant's Specification and in figure 1 in Mitani is a relationship that is well known and understood to those skilled in the art. Appellant submits that Mitani is using this relationship in their figure 1 to show when the compressor is in a surge condition and when it is not. Appellant submits that Mitani does not store the compressor map that they show in their figure 1 to be used in the system because Mitani does not use the compressor map to determine when their compressor is approaching the surge condition. Appellant submits that nothing in Mitani would teach

or suggest to one of ordinary skill in the art that the Mitani system uses any type of input signal, such as airflow rate, compressor speed, discharge pressure, etc., to determine the location on a compressor map that the compressor is currently operating. Appellant submits that the figures and discussion in Mitani do not show any device that would provide such a signal. Lines 22-24 on page 4 of the translation of Mitani states that the opening and closing of the flow regulating valve 18 "is controlled by an actuator (not shown) operated based on the air flow rate flowing in the gas supply line 15 and the rotary speed of the turbo-compressor as input signals." Appellant respectfully submits that this is different than using the speed of the compressor to determine where on a compressor map the compressor is operating, and then using this determination to decide whether to take steps to prevent compressor surge.

Appellant respectfully submits that just because Mitani shows a compressor map does not mean that this map is stored and used to determine the location on the map the compressor is operating for surge prevention purposes. Appellant submits that using compressor speed and/or other signals to determine where on a compressor map the compressor is operating is different than looking only at air flow rate and compressor speed to determine compressor operation.

Appellant submits that the Mitani system does do is determines that the compressor 12 is already in a compressor surge condition, and then takes action by opening the regulating valve 18 to remove the compressor surge condition. This is evident by the abstract where it states, "when the operating condition of the compressor 12 comes in the area A where surging takes place a flow rate regulating valve 18 is opened to the desired degree". Also, lines 34-35 on page 4 of the translation state, "[a]s for its controls, if the operational conditions of the compressor 12 enter the surging generation area A as shown in Fig.1, the flow rate regulation valve 18 is opened

appropriately." Thus, even though the last line in the abstract states that the surge condition is prevented, Appellant submits that this is not entirely accurate in that the surge condition does occur prior to the Mitani system taking suitable action. That portion of the abstract states effectively preventing the generation of surging. Appellant submits that what this means is that the surge condition is quickly removed after it has only occurred for a minimal amount of time.

The Examiner states on page 6 of the Final Office Action that:

> It is inherent from the teachings of Mitani that a controller is used to provide a signal to the motor to control the speed of the compressor. The Mitani reference also teaches effectively preventing the generation of surging by using the operating condition of the compressor to determine the location on the compressor map that the compressor is operating. (See abstract). Therefore, the compressor map would necessarily be stored in the controller in order to determine whether the compressor is approaching an area where surging takes place. Further, in order to prevent the generation of surging, suitable action would necessarily be taken before the compressor enters the surge condition.

Appellant respectfully submits that the Examiner has merely stated that Mitani inherently teaches Appellant's claimed limitation of storing a compressor map to identify the compressor operating conditions to prevent compressor surging without supporting this position. Appellant submits that Mitani does not say anything about determining the location on the compressor map that the compressor is operating and using that information to take appropriate action to prevent the compressor from entering a surge condition. Contrary, Appellant submits that what Mitani does teach is that the Mitani system detects that the compressor has entered a surge condition before it takes appropriate action.

As discussed above, Appellant submits that the Mitani system detects that the compressor 12 is already in a compressor surge, and then takes action by opening the regulating valve 18 to remove the compressor surge condition. In Appellants claim

invention, the compressor speed is monitored so that as the operating parameters of the compressor approach the surge line in the stored compressor map, suitable action can be taken before the compressor enters the surge condition to prevent compressor surge.

4. Dependent claim 19

Dependent claim 19 states that the method for preventing compressor surge also includes measuring the airflow to the compressor and using the compressor map to determine the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow. Appellant respectfully submits that there is no teaching in Mitani of measuring the airflow to the compressor and using the compressor map to determine the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow, and that the Examiner has not provided any discussion as to where in Mitani such a teaching can be found.

B. Claims 1, 2, 4-6, 13, 16 and 17 are not obvious in view of Aramaki and Mitani

Aramaki discloses a fuel cell system that includes an airflow meter 4 provided downstream from a compressor 2 in a cathode input line and a back-pressure valve 14 in a cathode output line. A controller 20 receives an airflow signal from the airflow meter 4 and controls a motor 15 that operates the compressor 2.

Appellant recognizes that it is known in the art to employ an airflow meter and a back-pressure valve in the cathode side of a fuel cell system. However, Appellant submits that Aramaki does not teach, suggest, disclose or mention any technique or method for preventing compressor surge of the compressor 2. Aramaki clearly does not use the airflow signal from the airflow meter 4 to determine the discharge pressure of

the compressor 2 and use this information to determine the location on a compressor map at which the compressor 2 is operating. The Examiner acknowledges on page 4 of the Final Office Action that Aramaki does not teach storing a compressor map of a compressor, determining the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow signal from a mass flow meter, determining the location on the compressor map at which the compressor is operating and preventing the compressor form entering a surge condition.

As discussed above, Appellant submits that Mitani also does not teach or suggest storing a compressor map to determining the operating condition of a compressor in a fuel cell system and using this information to prevent the compressor form entering a surge condition. Also, Appellant submits that Mitani does not teach determining the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow from a mass flow meter. Therefore, Appellant respectfully submits that Aramaki fails to provide the teaching missing from Mitani that can make Appellant's claimed invention obvious.

C. Claim 3 is not obvious is view of Aramaki, Mitani and Stenersen

As discussed above, Appellant submits that the combination of Aramaki and Mitani does not teach storing a compressor map of the operation of a compressor in a fuel cell system, determining where on the compressor map the compressor is operating and preventing the compressor from entering a surge condition based on this determination. Stenersen also does not teach or suggest detecting compressor surge in a fuel cell system. It is believe that Examiner is using Stenersen to teach that centrifugal, radial axial and mixed flow compressors are known, as Appellant has set forth in paragraph [0006] of the specification.

VIII. Conclusion

Appellant respectfully submits that claims 18 and 19 are not anticipated by Mitani, claims 1, 2, 4-6, 13, 16 and 17 are not obvious in view of Aramaki and Mitani and claim 3 is not obvious in view of Aramaki, Mitani and Stenersen. It is therefore respectfully requested that these rejections be withdrawn.

Respectfully submitted,

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CLAIMS APPENDIX

COPY OF CLAIMS INVOLVED IN THE APPEAL

1. A fuel cell system comprising:

a fuel cell module including a cathode input responsive to a charge airflow and a cathode exhaust;

a compressor generating the airflow applied to the cathode input of the fuel cell module;

a mass flow meter responsive to the airflow sent to the compressor, and generating a signal indicative of the speed of the airflow through the compressor;

a motor for driving the compressor; and

a controller responsive to the signal from the mass flow meter, said controller providing a signal to the motor to control the speed of the compressor, said controller storing a compressor map of the compressor, said controller determining the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow signal from the mass flow meter, said controller further determining the location on the compressor map at which the system is operating and preventing the compressor from entering a surge condition.

2. The system according to claim 1 wherein the compressor is a turbo-machine compressor.

3. The system according to claim 2 wherein the compressor is selected from the group consisting of centrifugal, radial, axial and mixed flow compressors.

4. The system according to claim 1 further comprising a back pressure valve positioned in the cathode exhaust, said back pressure valve controlling the pressure in the fuel cell module, said controller controlling the orientation of the back pressure valve to prevent the surge condition.

5. The system according to claim 1 further comprising a by-pass valve in the cathode exhaust, said controller controlling the by-pass valve to prevent the surge condition.

6. The system according to claim 1 wherein the fuel cell is on a vehicle or a distributed generation power system.

13. A fuel cell system comprising:

a fuel cell module including a cathode input responsive to a charge air flow and a cathode exhaust;

a compressor generating the airflow applied to the cathode input of the fuel cell module;

a motor that drives the compressor; and

a controller providing a signal to the motor to control the speed of the compressor, said controller storing a compressor map of the compressor, said controller using the compressor map and the speed of the compressor to determine the location on the compressor map that the compressor is operating and prevent the compressor from entering a surge condition.

16. The system according to claim 13 wherein the compressor is a turbo-machine compressor.

17. The system according to claim 13 further comprising a back pressure valve positioned in the cathode exhaust, said back pressure valve controlling the pressure in the fuel cell module, said controller controlling the orientation of the back pressure valve to prevent the surge condition.

18. A method for preventing a surge condition of a compressor in a fuel cell system, said method comprising:

storing a compressor map of the compressor;

driving the compressor at a desirable speed; and

using the compressor map and the speed of the compressor to determine the location on the compressor map that the compressor is operating and prevent the compressor from entering the surge condition.

19. The method according to claim 18 further comprising measuring the airflow to the compressor and using the compressor map to determine the discharge pressure and temperature of the compressor from the speed of the compressor and the airflow.

EVIDENCE APPENDIX

There is no evidence pursuant to §1.130, §1.131 or §1.132.

RELATED PROCEEDINGS APPENDIX

There are no decisions rendered by a court or the Board in any proceeding identified in Section II of this Appeal Brief.